From:	Branson, Eric
To:	Potter, Dolly; Stuble, Bill; Brown, Tim; West, Scott; Skogley, Bob
Subject:	RE: CA-1&2 on coal CEMs
Date:	Friday, March 19, 2004 1:59:53 PM
Attachments:	wsram2.pdf

An interesting article by EPA on the optical stack measurement and FT-NIR technologies...

From: Branson, Eric
Sent: Friday, March 19, 2004 1:27 PM
To: Potter, Dolly; Stuble, Bill; Brown, Tim; West, Scott; Skogley, Bob
Subject: RE: CA-1&2 on coal CEMs

FYI,

Here is some information on infrared stack gas analyzers and optical stack flow sensors. I don't believe that we will need FT-NIR (Fourier Transform - Near-Infrared) Analyzer since it would likely be overkill.

http://www.yokogawa.com/an/ir-gas/an-sg800-001en.htm

http://www.opticalscientific.com/OFS2000.htm

Eric

From: Potter, Dolly
Sent: Friday, March 19, 2004 1:01 PM
To: Stuble, Bill; Branson, Eric; Brown, Tim; West, Scott; Skogley, Bob
Cc: Phillip, Jim; Hughes, Ron; Hodgson, Rich
Subject: CA-1&2 on coal CEMs

Bill, Eric, Tim, and I met today to discuss the gas-to-coal permit condition #17 which requires continuous NOX, O2, and air flow monitors on the CA-1&2 common stack. NOX compliance will be based on lb/MMBtu and pph with a 30-day rolling average. The purpose of the oxygen monitor is to determine the Btus consumed so lb/MMBtu can be calculated; the air flow will give us pph. We are concerned about the use of an O2 monitor to determine fuel consumption due to dilution with tramp air, especially if one calciner is not running. A CO2 monitor won't work either, because of the CO2 evolved during calcination. We believe measuring coal consumption on a daily basis is a viable alternative. Regarding measuring air flow, we are concerned that a traditional pitot tube system would readily plug. Eric suggested the possibility of either an optical flow sensor or NIR (near infra red) system.

Action items:
Bill will contact Detroit Stoker to discuss measuring the amount of coal being burned. He will also contact an employee at Jim Bridger who is in charge of boiler emission measurements to inquire about the type of monitors they

EPA WORKSHOP
ON
OPTICAL REMOTE SENSING TECHNOLOGIES

Executive Summary

A Workshop on Optical Remote Sensing Technologies was held in the auditorium of the Environmental Protection Agency's (EPA) Environmental Research Center in Research Triangle Park, NC on July 31, and August 1, 2001. The Workshop was convened by John Bosch of the Emissions Monitoring and Analysis Division of EPA's Office of Air Quality Planning and Standards, and sponsored in part by ARCADIS, an environmental contractor supporting EPA's research on Optical Remote Sensing. Invited participants were technology providers, regulators, end-users and benefactors.

On the first day of the Workshop, the technology researchers/vendors provided brief discussions of the current state of the technology, as well as describing both commercially available instruments and instruments in the developmental stage prior to commercial availability. Generally, the presentations demonstrated that, while some areas continue to require further development, many ORS technologies have advanced well beyond their current level of deployment in the marketplace. In other words, from a technical standpoint, ORS technologies are capable of much broader application than that seen at present. Vendor organizations expressed frustration at their inability to move many technologies beyond the research phase into broader application in the environmental market. Significant advancements and improvements shown are in the following areas:

- Temporal and spatial resolution
- Range (distance) of measurements
- Detection levels
- Number of compounds detectable
- Plume imaging
- Cost effectiveness

A panel discussion, consisting of representatives of various organizations within EPA, convened during the afternoon session to address the direction of marketability for new technology, and its importance in the industry. Panel participants were instructed to emphasize incentives and impediments to the development and implementation of new technologies. The panel's consensus was that focusing technology development on areas of immediate concern and areas where it was possible to implement new technologies to achieve reduced costs (either for the Agency, or more importantly for the end users) provides the best opportunity for future success. Important future needs identified included improved capabilities for continuous monitoring of Hazardous Air Pollutants (for potential cap and trade approaches), as well as mercury and fine particulate matter monitoring.

A second panel discussion, consisting of representatives of prospective end users of ORS technologies, was convened to kick off the second day of the Workshop. Panel participants included staff from the Department of Defense, EPA Regions, and various state environmental compliance agencies. The presenters emphasized the need for technologies to address specific needs in order to have the best chance of success. Several presenters indicated that ORS does offer the potential to address specific needs, but expressed concerns in regards to acceptance of data by all relevant regulatory agencies.

A panel of representatives of funding organizations was convened next. The panel included staff from the EPA, NASA, and various DOD groups. Details of funding mechanisms were provided. A recurring emphasis was cooperation and cofunding between industry and regulatory agencies.

The Workshop concluded with open discussion on how to build and maintain momentum for application of ORS technologies. Approaches identified included the following:

- Increased cooperation and involvement between technology developers, regulators, and end users at the early stages of technology development
- Improved focus on specific issues of immediate concern to the regulated community as opposed to attempting to cure all ills
- Increased technology transfer through actions like additional workshops/presentations

The presence of participants in this workshop does not reflect endorsement for any kind of technology or equipment. The purpose was to bring together interested parties in the field and allow collaboration for potentially expanding remote sensing technology. The workshop represented an economical way to come together to address issues and to learn more about the most current available technologies.

SUMMARY OF TECHNICAL PAPERS (in order of presentation)

Ram A. Hashmonay, ARCADIS

Dr. Hashmonay was the chair of the technical session and the first speaker of the day. Several references on how ORS technologies have developed were presented. Reasons for the current limited applications of remote sensing technologies were discussed. Premature "as is" use, misinterpretation of the path integrated concentration data, disapproval of regulatory agencies, and the use of dispersion modeling assumptions were mentioned as a partial list of "what went wrong".

An overview of the current state of the art was given with emphasis on the technology's maturity and improved capabilities. These advances in detection levels and speed of measurement significantly increase the feasibility of using multiple beams approaches to better account for spatial and temporal variability of measured plumes. Simple multiple beam and innovative tomography approaches developed by Dr. Hashmonay and others caught the interest of the EPA as viable for directly analyzing fugitive emissions of open area sources using ORS. The ability of ORS to provide actual numbers on emissions to regulators, without applying indirect inverse modeling approaches, is a step towards overcoming some of the difficulties with ORS detailed previously.

Robert H. Kagann, EDO-AIL

Dr. Kagann discussed the use and history of Open Path Fourier Transform Infra Red Spectroscopy (OP-FTIR) for emissions characterization. A basic set-up for making OP-FTIR measurements was presented. The very high efficiency of OP-FTIR was emphasized and the advantages were enumerated as follows:

- Fast measurements – a 1 minute measurement interval provides a good instrument sensitivity along a 100 meter measurement path-length
- Remote sensing - can take measurements in inaccessible areas
- Area coverage – typical data is path-integrated concentration. Tomographic techniques, as earlier presented by Dr. Hashmonay, can provide direct measurement of fugitive emission fluxes
- Near real time - a calibration check in the field using TO16 EPA method is needed

This technology was first applied in the laboratory in the late 70's. Since its inception, the Clean Air Act Amendment has promoted more serious requirements. Availability of commercial instruments arose. The compendium TO16 Method was developed, and the Europeans followed suit in developing and promoting optical remote sensing technologies.

Harold Schiff, Unisearch Associates

Dr. Schiff represented Unisearch Associates, which manufactures all types of spectroscopic instrumentation. His presentation focused mainly on Tunable Diode Laser Systems (TDLS).

Laser wavelength depends on the crystal composition and the width of laser line is very narrow, essentially eliminating any interferences. The advantages of using an open path diode laser include:

- Telecommunications spectral range – the instrument can easily be connected with fiber optic cable and be located anywhere
- Can carry out measurements from different locations simultaneously
- System has automatic calibration

Optical sensing using TDLS gives the option of multiplexing combined with high sensitivity. This allows a fast measurement of many beams in few seconds and can apply the tomographic approaches previously discussed. Generally, one laser is utilized for each gas to be measured. However, several lasers can be combined in one unit if required. TDLS is the best way to measure one or a limited number of gases, with higher sensitivity results, quick response time and lack of interference. Several examples of open path TDLS applications along with an example of a hybrid TDLS/DOAS system for fast multiple compound measurements, were presented.

<u>N. Scott Higdon, ITT Industries</u>
Mr. Higdon presented a number of ITT's custom systems that are under various stages of development, including the following:

- LIDAR for detecting particulates or dust (fully developed); this eye-safe aerosol system developed for Hampton University is a powerful mapping tool
- Differential Absorption LIDAR (DIAL) for detection of gases and chemical agents over unprecedented long ranges via receiving signals from distant hard targets. Applying radial tomography will achieve large-scale plume mapping
- Raman Scattering to detect surface molecular contamination and biological agents, most applications being in support of the military
- Hg measurement using the DIAL techniques, including plume mapping

<u>John Otten, Kestrel Corporation</u>
Kestrel Corporation focuses on spectral imaging technology, according to Dr. Otten. The airborne applications are mostly in support of the military (surreptitious surveillance and rocket launching). Leak detection of rocket plumes during testing is very crucial to identify/pinpoint any problem prior to rocket launching, thus averting any catastrophic accidents. These FTIR-based imaging systems may be modified into a simultaneous multiple beam OP-FTIR system that can apply tomographic approaches.

<u>Wynn L. Eberhard, Environmental Technology Laboratory, National Oceanic and Atmospheric Administration</u>
Currently, ETL has 6 aerosol, 3 Doppler, and 2 Ozone Lidar measurement systems in place. Furthermore, ETL is involved in research areas attempting to advance Lidar technology for use in new scientific applications. Issues in air quality in the U.S. and Europe are prompting the research and development of optical methods to better measure

ammonia. ETL has developed and demonstrated NH_3 plume measurement capability with DIAL.

Ting I Wang, Optical Scientific Inc.
Dr. Wang described two path-integrated flow meters. These optical anemometers, which utilize a pair of parallel laser beams and receivers, measure the scintillation from one receiver to the next. Determining the temporal correlation between the two signals is related to the wind speed. In the long path instrument, the air velocity along a 200-900 m long path, such as in an aluminum smelter pot room roof vent, can be measured. Optical flow sensing was approved as an equivalent Method 14 technology for compliance with the USEPA MACT rules. The EPA has applied the optical anemometer technology for other environmental airflow.

The Optical Flow Sensor (OFS) measures airflow in a stack or exhaust duct. The OFS is installed at one level and measures through glass windows across the stack or duct. The data are verified by testing at the NIST Wind Tunnel. The OFS affords advantages, which the other methods do not offer, including:

- Non-intrusive, not directly exposed to the stack flow
- Path averaged measurement for more representative results
- Simple, non-angled installation which lowers cost vs. ultrasonic
- Result independent of temperature and pressure
- Direct cross-stack velocity measurement
- No moving parts, solid-state construction

Cary Secrest, EPA Office of Enforcement and Compliance Assurance
UV/DOAS is the simplest application of remote sensing, yet it can yield powerful results. From a regulatory standpoint open path can help with enforcement and lower costs. Measurement comparisons between UV/DOAS and FTIR were in agreement and demonstrate the utility of using multiple beams to promote better understanding of measured data.

Tom Reichardt, Sandia Labs
Sandia Labs is currently developing a laser-based imaging system for detection of fugitive emissions from refineries. They have also worked on topographical LIDAR. Active Laser-IR is better than conventional leak detection methods (hand-held sniffer). It allows rapid broad range area coverage for easy recognition and source location of plumes. It accelerates the leak detective process, which may decreases costs for environmental compliance.

There are currently several technologies in development. Gas can be seen regardless of temperature because active imaging is not temperature dependent unlike the passive imaging. The disadvantage of the active imaging is it needs a reflective source. Smaller portable systems are necessary. Compliance monitoring will drive future further marketability. The petroleum industry may be first in line to decrease their compliance costs.

Bob Hinnricks, Pacific Advantage Technologies
Their group is working on a gas detection spectrometer primarily applicable to underground leak testing. Infrared imaging can easily detect underground methane leaking to the atmosphere. The flow is not accurate at this time, but good results demonstrated that even low level leaks could be detected. The technique can also be applicable to the propane industry. Propane, other gases and hydrocarbon soots were identified as well. Another application of this technique is for tank leak detection. The instrument may be available by mid-2002.

David Green, Physical Sciences, Inc.
Their company has worked with the EPA/SBIR Program on a tunable diode laser. The goal is to develop a portable device that is affordable and practical. This is very useful in methane detection or any gas leak detection survey. Its sensitivity is in the ppm range. It only weighs 9 pounds and is rugged. To date, 70 devices have been delivered. Passive imaging instrument has been developed as well. The cost is about $10,000 per unit and will be available in 18 months.

Michael Calidonna, US Air Force
Lt. Calidonna discussed a project for opacity test method development. The current method for opacity test is based on EPA Method 9, which is an eyeball calibration. The EPA method is tiring, time consuming, non-reproducible and subjective. The new test method offers a better way of measuring opacity in a smoke stack. It is a digital camera-based method, involving a simple point and click operation after a 10-minute set-up. It has built-in algorithms that are tamper-proof. The results are permanent and reproducible. Litigation costs and fines, etc. can be avoided with this technology. In two to three years time, this new technology will need method validation, which will be followed by a six months certification process. The cost is approximately $5,000 per unit.

EXPERT PANEL FOR NATIONAL REGULATORY PROGRAMS AND POTENTIAL APPLICATIONS

David Mobley, Director of the Emissions, Monitoring and Analysis Division of EPA's Office of Air Quality Planning and Standards (OAQPS)
Introduced the panel and provided an overview of the subsequent discussion. The subjects were incentives and impediments encountered in balancing the need and the desire to develop and use new technologies.

Barrett Parker, Emissions Measurement Center, OAQPS
Mentioned incentives for increased measuring, such as Title V and CAM rules and maximum standards. MACT standards expansion will also drive monitoring needs. Residual risk determinations will also require ambient air toxics measurement. Many sources are apprehensive when it comes to using an advanced monitoring system for fear that the results may be used against them. There is a need for user-friendly instruments that have on-going calibration capability.

Karen Riggs, Batelle (representing EPA's ETV Program)
Focused on the EPA's Environmental Technology Verification (ETV) program. There are about 100 stakeholders of which there are no vendors. The stakeholders advise ETV on how to run the program, what monitoring technology is needed, and which of the technologies are important to be verified. ETV's focus is primarily on field technology. Of importance are mercury contaminants emissions monitoring, multi-metal monitoring and open path systems. ETV is involved in the technology verification but not in technology approval.

Tom Pace, Emission Factor and Inventory Groups, OAQPS
Emission inventories are the fundamental building blocks for doing air quality management. It is impossible to measure everywhere, so some sources are measured and emission factors developed. Open path technologies will be helpful in monitoring emissions from open sources, fugitive dusts, ammonia, all kinds of fires and mobile sources for pollutants. The incentive is to get better information, which with more accurate planning will help avoid repetition that costs time and money.

Cary Secrest, EPA/OECA
EPA faces an impediment to using ORS technology in that there are only minimal funding resources set aside and even less time is available. Legal issues may impede industry from utilizing ORS technologies.

Dan Powell, Technology Innovation Office, EPA's Office of Solid Waste and Emergency Response (EPA/OSW)
While admittedly focusing on cleanup of water and soil, Mr Powell indicated that there should be incentives for employing new technologies and dealings with some of the impediments in trying to develop more defensible data/information. Performance-based measurements could be included in site assessment and site activity.

Barry Lesnik, Economics, Methods and Risk Analysis Division, EPA/OSW
He stressed that EPA SW846 methodologies were not reference methods and could be modified to fit specific applications

J. D. Bachmann, Senior Science Advisor, EPA/OAQPS
He introduced the idea that ORS technologies could play a role in enabling the development of a "cap and trade" approach for air toxics similar to the one that has been successfully employed in the Acid Rain Program. Continuous monitoring methods are the cornerstone for such a program and ORS offers a unique approach. He was very interested in the concept of facility-wide measurements.

END-USER PERSPECTIVES

Rochelle Williams, U. S. Army Forces Command, Atlanta, GA
There is a need for a defensible data for DOD to demonstrate compliance during training activities. It must be done right and scientifically. The U. S. Army does a lot of testing for emission characterization from munitions and artillery and there are limited in what they can adequately measure. At this time, they are unable to characterize a 3-dimensional plume effectively. This 3-D mapping could help in dispersion models for risk assessment based on these air emissions.

Additional needs for characterization include fog oils and other obscurants which have been perceived as potentially hazardous by some state environmental organizations. She added that whatever technologies are developed, it is important that they be "idiot proof" to allow them to be used by enlisted personnel with a minimum of training.

Dennis Goodenow, California Air Resources Board
CARB routinely does two types of air monitoring as follows:

- ambient air quality monitoring (ongoing projects)
- special purpose air quality

He felt that ORS could be an important tool for the latter. CARB is concerned about monitoring impacts to high-risk populations (e.g., schools, hospitals, etc.). Some current areas of concern that may offer applications for ORS include:

- children's emissions initiative – monitoring emissions in homes and playground, etc. to check what chemicals are the children exposed to.
- Pesticide monitoring
- Toxics' control identification – there are 188 HAPS that need to be identified
- Controlled burns in military bases
- Emergency response (toxic spills, tire fires)

Van Shrieves, EPA Regional Office IV, Atlanta, GA
Region IV currently has two DOAS instruments in use for monitoring and they have conducted some special studies. He would like to see additional information exchange to better spread the word about ORS capabilities.

Rick Taylor, Missouri State Environmental Protection Agency
He has successfully applied ORS methods and believes they word well when applied correctly. In 1995, Missouri was able to identify only 6 analytes with the OP-FTIR. This number has greatly increased to 76 identified compounds with the current technology. ORS methods have been or will be applied at sites such as swine farms, landfills, and wastewater treatment plants. Multiple optical measurements (tomography) are non-biased and offer temporal resolution, providing a huge advantage over conventional, "grab" sampling methods such as SUMMA canisters. Furthermore, computerized samples are non-degradable and therefore have better sample integrity.

ACTIONS NEEDED TO CREATE AND SUSTAIN MOMENTUM

Bill Vaughn, Chairman of the AWMA Division on Remote Sensing
AWMA's mission is to assist in professional development and critical environmental decision making to benefit society. AWMA's purpose is to enhance knowledge and provide quality information on which to base environmental decisions. The technologies can provide real time data on multiple pollutants to inform regulators and the public.

Jim Gallup – EPA manager of Small Business Innovative Research (SBIR) programs
SBIR funding is available to companies with less than 500 employees. There is a 1 in 10 approval. There are two phases in the funding program as follows:

- Phase I - $70,000 grant money for six months to prove the feasibility of the technology
- B) Phase II – can be as much as $750,000. Open to competition among companies

The program does a lot of SBIR National Meetings across the country where companies will listen to what is being offered at all agencies. Most of the proposals seen in the measurement or monitoring areas are from companies that have worked with Department of Defense and National Aeronautic Space Administration.

Bob Holst, DOD Manager for SERDP/ESCTP involving environmental compliance projects
This is a 3-Agency partnership (DOD-DOE-EPA). DOD solicitations include basic and applied research/advanced development (SERDP) and demonstration/validation (ESCTP).

Four thrust areas in SERDP include:

- clean-up – cleaning up of unexploded materials
- conservation – to locate endangered species, maintenance and restoration
- compliance area – ensuring that DOD activities meet environmental standards
- HAPS substitution

Fine PM and dust are considered to be major issues looming on the compliance horizon.

Bill Grant, Lidar Applications Group, NASA Langley Research
NASA has interest in the global troposphere and stratosphere. They are mainly interested in the chemistry and dynamics of the radiation budget of the atmosphere. Global airborne measurements characterize background atmosphere at different parts of the world. Asian emissions are being checked out due to increasing concerns. Sea transport is fairly efficient in this part of the world. NASA has no need for further remote sensing, but this is an opportunity for coordination with other EPA groups, NOAA type programs in the US.

NASA is interested in technology/instrument capable of hydrazine detection at the ppb level. At this time, it is very difficult to detect hydrazine leaks from containers at the Cape. Detection of hydrogen leaks from shuttle engines is also of interest to NASA.

Larry Jones – Chief, EPA/ORD/NRMRL/APPCD Emissions Characterization and Prevention Branch
He gave an overview of what his branch does and the technology used. They have used OP-FTIR in radial tomography configuration as earlier presented by Dr. Hashmonay, to measure emission fluxes from animal waste operations (swine regulations and looking into poultry as well).

Susan Thornloe – Scientist, EPA/ORD/NRMRL/APPCD Atmospheric Protection Branch
ORD is looking for better methods for emissions measurements. Joint ventures with industry are highly recommended due to funding restraints. One ongoing project involves a new type of landfill technology. Bioreactors enhance decomposition processes within landfills and produce landfill gas at faster rates, making energy recovery from landfills more cost effective. Increased fugitive emissions are of concern. Applications of the new tomographic approaches are under consideration to address the issue. Other pollutants like mercury should be better understood to determine whether they are an issue for human or ecosystem health. The status of current knowledge is outdated. Partnership with industry is the best way to move forward

Michael Calidonna – Project Manager, USAF Research Laboratory, Tyndall AFB, FL
The USAF has worked on numerous occasions with other governmental organizations. NASA has provided some seed money, and USAF has coordinated partnerships with DOD and EPA. One difficulty discussed was the issues related to getting buy in for technologies from federal and state regulators. This can cost the vendor a lot of invested time. One successful approach involves getting together with regulators in advance to discuss potential issues. Funding for development is available through numerous different channels. Lt. Calidonna expressed his concern that EPA's perceived convoluted chain of command often slows approval processes. It is important for vendors to understand the DOD needs, and to routinely follow up with contacts in order to address the issues. One particular need he expressed involved sensing biochemical and biological hazards to prevent military casualties.

use. If appropriate, we will ask to visit the power plant to see the monitors.

Eric has agreed to further investigate optical flow sensing and NIR, including the price and applicability for our system.

Tim or I will contact the stack testing firm we use to see if they have alternative ideas.

Since this issue needs to be resolved before the end of the comment period on April 5, Bill and I are targeting a visit with WDEQ-AQD on Friday, March 26.

Dolly

Dolly A. Potter
Environmental Services Supervisor
Solvay Chemicals, Inc.

phone: (307) 872-6571
fax: (307) 872-5879

General Specifications

IR400 NDIR TYPE INFRARED GAS ANALYZER (5-CONPONENT ANALYZER)

GS 11G02N01-01E

This gas analyzer (IR400) is capable of measuring the concentrations of NO, SO_2, CO_2, CO, CH_4 and O_2 components in sample gas.

NO, SO_2, CO_2, CO and CH_4 are measured by non-dispersion infrared method (NDIR), while O_2 is measured by built-in type paramagnetic method sensor or external-mount type zirconia method sensor. A maximum of 5 components including O_2 (max. 4 components except for O_2 measurement) are simultaneously measurable.

The mass flow type twin detector of high sensitivity and reliability adopted in the infrared ray method detection block makes the measurement hardly affected by interfering components.

In addition, a microprocessor is built in and a large-size liquid crystal display is equipped for easier operation, higher accuracy and more functions.

Optimum as an analyzer unit of measurement system for combustion exhaust gas from refuse incinerator and boiler, or gas from different industrial furnaces.

■ FEATURES

1. Measure five components including O_2 simultaneously and continuously
   Simultaneously and continuously measures up to four components out of NO, SO_2, CO, CO_2 and CH_4, plus O_2, or up to totally five components.
2. Hardly affected by interference by other gases
   The mass flow type twin detector of high sensitivity and reliability adopted makes the measurement hardly affected by interfering components, ensuring a stable operation.
3. Equipped with abundant functions
   O_2 conversion, average value computation, automatic calibration, one touch calibration, upper/lower limit alarm, remote measurement range changeover, range identification signal output, etc. incorporated can configure applications to match particular uses.
4. Easy-to-see large LCD unit
   The large LCD unit adopted allows observing easily the indication of all measured components and computation values.
   The interactive operation facilitates setting.
5. 19 inch rack mount structure
   The mainframe unitized to 19 inch rack type and electrical signal input/output terminal unit also unitized easily configure a gas analyzer system.

■ SPECIFICATIONS

Standard Specifications

Principle of measurement:

NO, SO_2, CO_2, CO, CH_4;
Non-dispersion infrared-ray absorption method
Single light source and double beams (double-beam system)

O_2 ; Paramagnetic method (O_2 sensor built in) or zirconia sensor method (O_2 sensor externally installed)

Measurable gas components and measuring range:

	Minimum range	Maximam range
NO	0 – 100 ppm	0 – 5000 ppm
SO_2	0 – 100 ppm	0 – 10 vol%
CO_2	0 – 50 pm	0 – 100 vol%
CO	0 – 100 ppm	0 – 100 vol%
CH_4	0 – 500 ppm	0 – 100 vol%
O_2 (built in)	0 – 5 vol%	0 – 25 vol%
O_2 (External Zirconia)	0 – 5 vol%	0 – 25 vol%

T01.eps

- Max. 5 components measurement including O_2.
- 1 or 2 measuring range per component.
- Measuring range ratio ≦ 1:5 (O_2 sensor)
  ≦ 1:20 (except for O_2 sensor)
  For measurable components and possible combinations of measuring ranges, refer to Tables 1-(1) to (7).

Measured value indication:

Digital indication in 4 digits (LCD with back light)
- Instantaneous value of each component
- Instantaneous value after O_2 correction (only in NO, SO_2, CO measurement with O_2)
- Average value after O_2 correction (only in NO, SO_2, CO measurement with O_2)
- O_2 average value

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Analog output signals:
* Inputs/outputs of analog signals are possible by combining with the input/output terminal module.

4 to 20 mA DC or 0 to 1 V DC, non-isolated output ; 12 points max.
Analog output corresponds to measured value indication in 1:1.
Permissible load resistance;
550 Ω max. for 4 to 20 mA
DC100 kΩ min. for 0 to 1 V DC
* Refer to Table 2, for the channel No. of displayed values and analog output signals.

Analog input signal:
For signal input from externally installed O_2 sensor.
Signal requirement;
(1) Signal from YOKOGAWA's Zirconia O_2 sensor (Model: ZX8D Style C)
(2) 0 to 1V DC from an O_2 sensor
Input section is not isolated. This feature is effective when an O_2 sensor is not built in.
(An input signal triggers measured concentration indication and O_2 conversion.)

Relay contact output:
1a contact (250 V AC/2 A, resistive load)
Instrument error, calibration error, range discrimination, auto calibration status and maintenance status, pump ON/OFF, peak alarm.
1c contact (250 V AC/2 A, resistive load)
Upper/lower alarm contact output. (for each channel)
Power disconnection alarm.
* All relay contacts are isolated mutually and from the internal circuit.

Contact input: No-voltage contact (ON/0 V, OFF/ 5V DC, 5 mA flowing at ON)
Remote range changeover, auto calibration remote start, remote holding, average value resetting, pump ON/OFF
Isolated from the internal circuit with photocoupler. Contact inputs are not isolated from one another.

Transmission output:
Solenoid valve drive signal for automatic calibration.
Transistor output (100 mA or less)

Rated operating conditions:
Power supply;85 to 264 V AC, 50/60 Hz (3-pin inlet terminal used)
Power consumption; 150 VA
Ambient temperature; –5°C to 45°C
Ambient humidity; 90% RH max.

Storage conditions:
Ambient temperature; –20°C to 60°C
Ambient humidity; 90% RH max., non-condensing

Dimensions (H × W × D):
Analyzer main unit;
177 × 483 × 690 mm
Input/output terminal module;
164 × 318 × 55 mm

Weight: Approx. 22 kg (only Analyzer)

Finish color: Front panel; Off-white (Munsell 10Y7.5/0.5 or equivalent)
Casing; Plating, Steel-blue (gray)

Enclosure: Steel casing, for indoor use

Material of gas-contacting parts:
Gas inlet/outlet; SUS304
Sample cell; SUS304/neoprene rubber
Infrared-ray transmitting window; CaF_2
O_2 sensor sampling cell : SUS316
Internal piping; Toaron tube, Teflon tube

Gas inlet/outlet: Rc1/4 or 1/4NPT internal thread

Purge gas flow rate:
1 L/min (when required)

Standard Functions

Output signal holding:
Output signals are held during manual and auto calibrations by activation of holding (turning "ON" its setting).
The values to be held are the ones just before start calibration mode.
Indication values will not be held.

Remote output holding:
Output signal is held at the latest value by short-circuiting the remote output holding input terminals.
Holding is maintained while the terminals are short-circuited. Indication values will not be held.

Remote range changeover:
Measuring range can be changed according to an external signal when remote range changeover input is received.
Changeover is effective only when remote range setting is turned on. In this case, measuring range cannot be changed manually.
When the contact input terminals for each component are short-circuited, the first range is selected, and it is changed over to the second range when the terminals are open.

Range identification signal:
The present measuring range is identified by a contact signal.
The contact output terminals for each component are short-circuited when the first range is selected, and when the second range is selected, the terminals are open.

Auto calibration:
Auto calibration is carried out periodically at the preset cycle.
When a standard gas cylinder for calibration and a solenoid valve for opening/

closing the gas flow line are prepared externally by the customer, calibration will be carried out with the solenoid valve drive contacts for zero calibration and each span calibration turned on/off sequentially at the set auto calibration timing.

Auto calibration cycle setting:
Auto calibration cycle is set.
Setting is variable within 1 to 99 hours (in increments of 1 hour) or 1 to 40 days (in increments of 1 day).

Gas flow time setting:
The time for flowing each calibration gas in auto calibration is set.
Settable within 60 to 599 seconds (in increments of 1 second)

Auto calibration remote start:
Auto calibration is carried out only once according to an external input signal.
Calibration sequence is settable in the same way as the general auto calibration.
Auto calibration is started by opening the auto calibration remote start input terminals after short-circuiting for 1.5 seconds or longer.

Auto zero calibration:
Auto zero calibration is carried out periodically at the preset cycle.
This cycle is independent on "Auto calibradion" cycle.
When zero calibration gas and solenoid valve for opening/closing the calibration gas flow line are prepared externally by the customer, zero calibration will be carried out with the solenoid valve drive contact for zero calibration turned on/off at the set auto zero calibration timing.

Auto zero calibration cycle setting:
Auto zero calibration cycle is set.
Setting is variable within 1 to 99 hours (in increments of 1 hour) or Setting is variable within 1 to 40 days (in increments of 1 day)

Gas flow time setting:
The timing for flowing zero gas in auto zero calibration is set.
Settable 60 to 599 seconds (in increments of 1 second)

Upper/lower limit alarm:
Alarm contact output turns on when measurement value reach to the preset upper or lower limit alarm value.
Contacts close when the instantaneous value of each component becomes larger than the upper alarm limit value or smaller than the lower alarm limit value.

Instrument error contact output:
Contacts close at occurrence of analyzer error No. 1, 3 or 10.

Calibration error contact output:
Contacts close at occurrence of manual or auto calibration error (any of errors No. 4 to 9).

Auto calibration status and maintenance status contact outputs:
Contacts close during auto calibration and during input of the remote hold signal.

Pump ON/OFF contact output:
During measurement, this contact close. While calibration gas is flowing, this contact open. This contact is connected in power supply of pump, and stop the sample gas while calibration gas flowing.

Optional Functions

O_2 correction: Conversion of measured NO, SO_2 and CO gas concentrations into values at standard O_2 concentration

Correction formula: $C = \frac{21 - On}{21 - Os} \times Cs$

C: Sample gas concentration after O_2 correction
Cs: Measured concentration of sample gas
Os: Measured O_2 concentration
On: Standard O_2 concentration (value changeable by setting)

* The upper limit value of the fractional part in this calculation is 4.
The result of calculation is indicated and output in an analog output signal.

Average value after O_2 correction and O_2 average value calculation:
The result of O_2 correction or instantaneous O_2 value can be outputted as an average value in the determined period of time.
Used for averaging is the moving average method in which sampling is carried out at intervals of 30 seconds.
(Output is updated every 30 seconds. It is the average value in the determined period of time just before the latest updating.)
Averaging time is settable within 1 to 59 minutes (in increments of 1 minute) or 1 to 4 hours (in increments of 1 hour).

Average value resetting:
The above-mentioned output of average value is started from the initial state by opening the average value resetting input terminals after short-circuiting for 1.5 seconds or longer.
Output is reset by short-circuiting and restarted by opening.

CO concentration peak count alarm:
(added only for CO/O_2 measurement)
Alarm output turns on according to the preset concentration and count.
Whenever the instantaneous value of CO exceeds the preset concentration value, count increments. If the count exceeds the preset value in one hour, the alarm contacts close.

Communication function:
RS-232C (9 pins D-sub)
Half-duplex bit serial

Start-stop synchronization
Modbus™ protcol
Contents: Read/Write parameters
Read measurement concentration and instrument status
Remark: When connecting via RS-485 interface, a RS-232C <−> RS-485 converter should be used.

Characteristics

Repeatability : ±0.5% of full scale
Linearity : ±1% of full scale
Zero drift : ±2% of full scale/week
Span drift : ±2% of full scale/week
Response time:
(for 90% FS response)
Within 60 seconds including replacement time of sample gas (when gas flow rate is 0.5 L / min)

Effects of interfering gases

When sample gas contains gas components listed below, the measurement accuracy may suffer. Consult Yokogawa for countermeasures or effect on accuracy.

Analyzer	Interfering	Effect
SO_2 analyzer	NO_2	50 ppm of NO_2 is equivalent to -6 ppm of SO_2
CO analyzer	CO_2	15% of CO_2 is equivalent to 7 to 10 ppm of CO
CO analyzer	NO_2	1000 ppm of NO_2 is equivalent to 80 ppm of CO
CH_4 analyzer	CO_2	15% of CO_2 is equivalent to 3 ppm of CH_4

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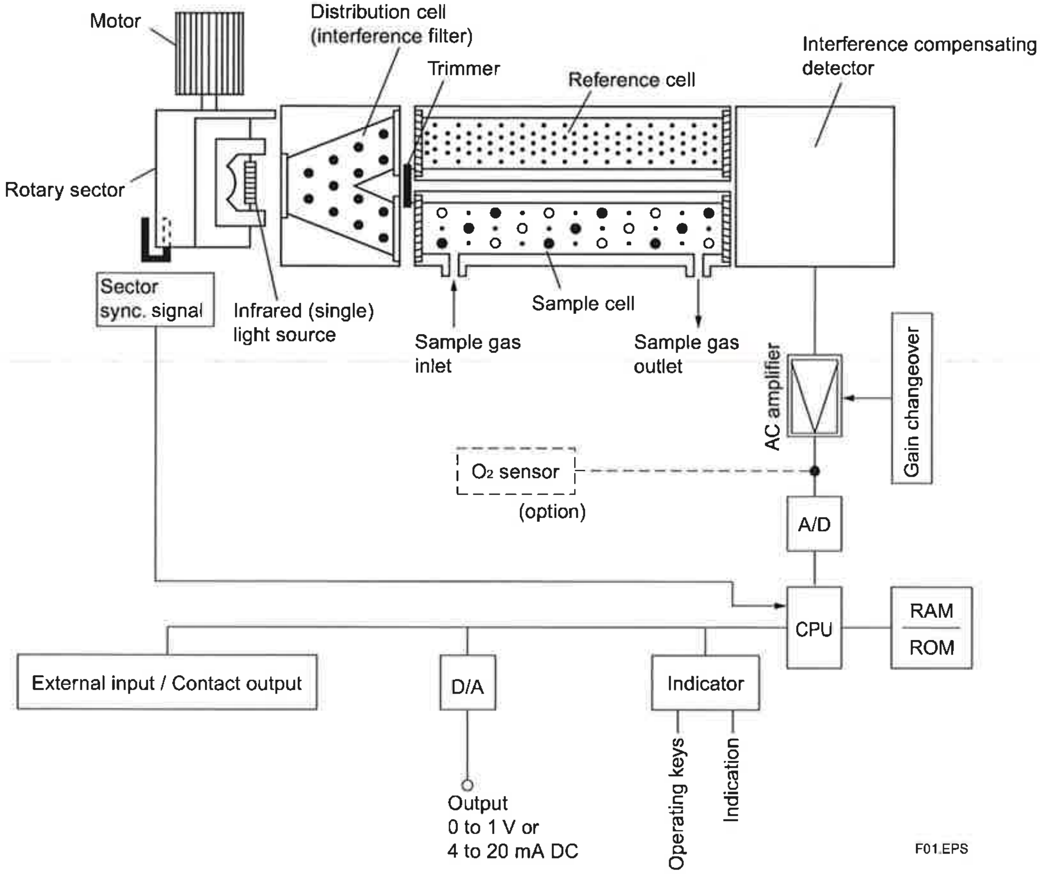
Standard Requirements for Sample Gas

Flow rate : 0.5L / min ±0.2 L / min
Temperature : 0 to 50°C
Pressure : 10 kPa or less (Gas outlet side should be open to the atmospheric air.)
Dust : 100 µg/Nm³ or less in particle size of 1 µm or less
Mist : Unallowable
Moisture : Below a level where saturation occurs at 2°C (condensation unallowable).
Corrosive component:
HCl 1 ppm or less
Standard gas for calibration:
Zero gas; Dry N_2
Span gas; Each sample gas having concentration 90 to 100% of its measuring range (recommended).
Gas beyond concentration 100%FS is unusable.
In case a zirconia O_2 analyzer is installed externally and calibration is carried out on the same calibration gas line:
Zero gas; Dry air or atmospheric air (provided without CO_2 sensor)
Span gas; For other than O_2 measurement, each sample gas having concentration 90 to 100% of its measuring range.
For O_2 measurement, O_2 gas of 1 to 2 vol%.

Installation Requirements

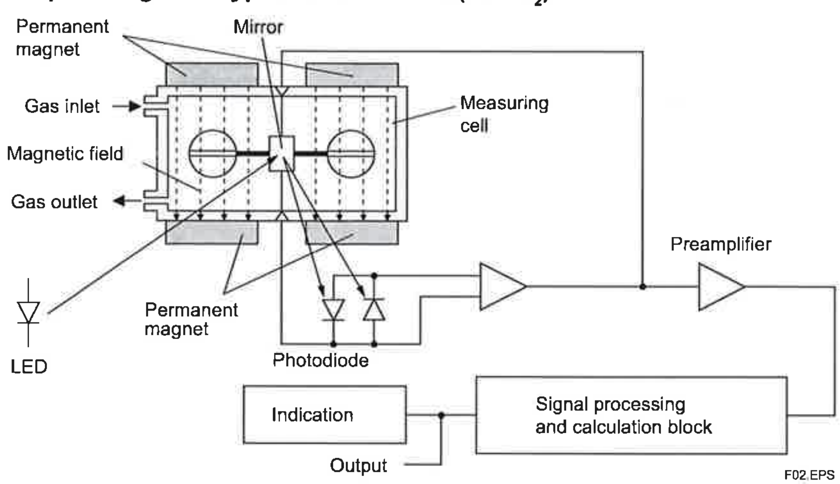
- Select a place where the equipment does not receive direct sunshine, draft/rain or radiation from hot substances.
  If such a place cannot be found, a roof or cover should be prepared for protection.
- Avoid a place where receives heavy vibration
- Select a place where atmospheric air is clean

Principle diagram of NDIR type measurement (For NO, SO_2, CO_2, CO, CH_4)



F01.EPS

Principle diagram of paramagnetic type measurement (For O_2)

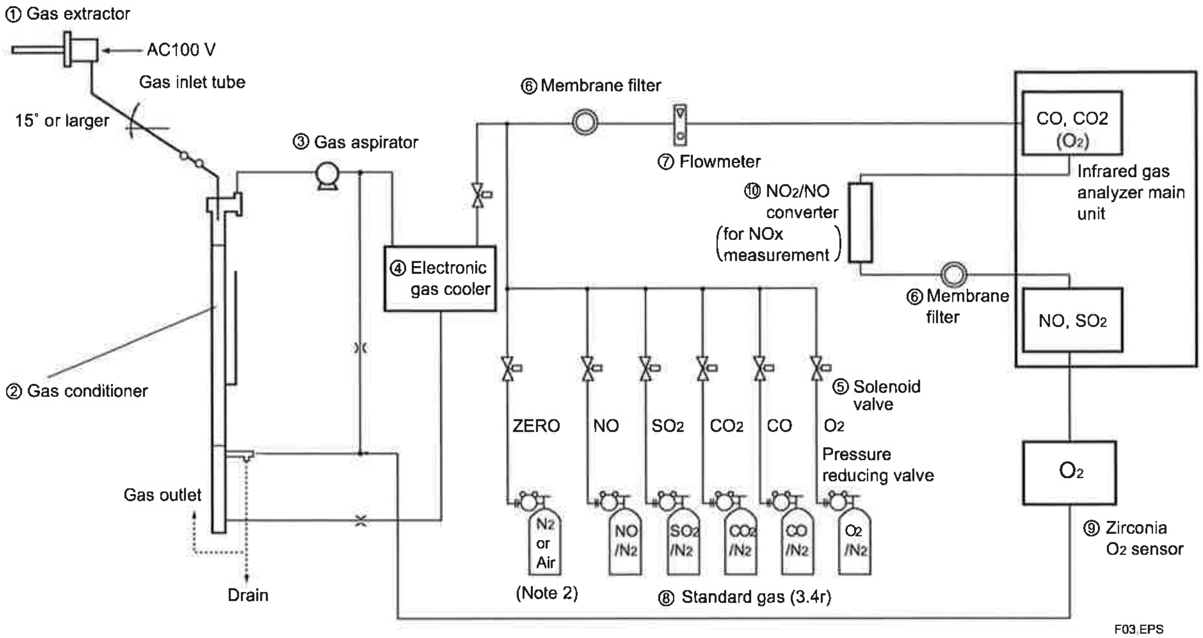


F02.EPS

Example configuration of gas sampling system

The following illustrates a typical system configuration for five component gas measurement for monitoring combustion exhaust gas from boiler, refuse incinerator, etc.

Contact YOKOGAWA for system configuration matching the particular use or further information.



Functions of Individual Components

1 . Gas extractor: Gas extractor with a heating type stainless steel filter of standard mesh 40 µm

2 . Gas conditioner: For separation of drain, prevention of drain from being sucked through secondary filter and composite operation of constant-pressure bubbler

3 . Gas aspirator: For aspiration of sample gas (sample gas flow rate approx. 2 L/min)

4 . Electronic gas cooler: Dries the moisture in sample gas.

5 . Solenoid valve: Used for introducing calibration gas.

6 . Membrane filter: PTFE filter used to eliminate fine dust particles and permit monitoring of dust adhering condition on the front panel of the gas analyzer.

7 . Flowmeter: Adjusts and monitors the flow rate of sample gas.

8 . Standard gas: Reference gas used for calibrating zero and span of the analyzer. Total 6 cylinders required for air, zero gas, span gas NO, SO_2, CO, CO_2 and O_2.

9 . Zirconia O_2 sensor: (This is not necessary in case when the zirconia type O_2 sensor is built-in.) External zirconia oxygen sensor used for measuring the oxygen concentration (0 to 25%) in sample gas.

10 . Converter: Added to NOx analyzer. A special catalyst material for efficient conversion of NO_2 gas to NO is used.

*(Note) For each gas sampling device, please contact YOKOGAWA.

MODEL AND SUFFIX CODE

Model	Suffix code	Option code	Description			
IR400			Infrared Gas Analyzer 19-inch rack mounting type with side rail			
Measurable component			1st	2nd	3rd	4th
	-A		NO			
	-B		SO_2			
	-C		CO_2			
	-D		CO			
	-F		CH_4			
	-G		NO	SO_2		
	-H		NO	CO		
	-J		CO_2	CO		
	-K		NO	SO_2	CO	
	-L		NO	SO_2	CO_2	CO
O_2 Analyzer	N		Not Available			
	1		External zirconia type sensor (use ZX8D Style C)			
	2		External O_2 Analyzer (note1)			
	3		Built-in paramagnetic type O_2 Sensor			
1st Component 1st Range (note2)	A		0–50 ppm (note3)			
	B		0–100 ppm			
	C		0–200 ppm			
	D		0–250 ppm			
	E		0–500 ppm			
	F		0–1000 ppm			
	G		0–2000 ppm			
	H		0–5000 ppm			
	J		0–1%			
	K		0–2%			
	L		0–3%			
	M		0–5%			
	P		0–10%			
	Q		0–20%			
	R		0–40%			
	S		0–50%			
	T		0–70%			
	U		0–100%			
1st Component 2nd Range (note2)	B		0–100 ppm			
	C		0–200 ppm			
	D		0–250 ppm			
	E		0–500 ppm			
	F		0–1000 ppm			
	G		0–2000 ppm			
	H		0–5000 ppm			
	J		0–1%			
	K		0–2%			
	L		0–3%			
	M		0–5%			
	P		0–10%			
	Q		0–20%			
	R		0–40%			
	S		0–50%			
	T		0–70%			
	U		0–100%			
	N		Not Available			
2nd Component 1st Range (note2)	B		0–100 ppm			
	C		0–200 ppm			
	D		0–250 ppm			
	E		0–500 ppm			
	F		0–1000 ppm			
	G		0–2000 ppm			
	H		0–5000 ppm			
	J		0–1%			
	K		0–2%			
	L		0–3%			
	M		0–5%			
	P		0–10%			
	Q		0–20%			
	R		0–40%			
	S		0–50%			
	T		0–70%			
	U		0–100%			
	N		Not Available			

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MODEL AND SUFFIX CODE

2nd Component 2nd Range (note2)	C		0–200 ppm
	D		0–250 ppm
	E		0–500 ppm
	F		0–1000 ppm
	G		0–2000 ppm
	H		0–5000 ppm
	J		0–1%
	K		0–2%
	L		0–3%
	M		0–5%
	P		0–10%
	Q		0–20%
	R		0–40%
	S		0–50%
	T		0–70%
	U		0–100%
	N		Not Available
3rd Component 1st Range (note2)	B		0–100 ppm
	C		0–200 ppm
	D		0–250 ppm
	E		0–500 ppm
	F		0–1000 ppm
	G		0–2000 ppm
	H		0–5000 ppm
	J		0–1%
	K		0–2%
	L		0–3%
	M		0–5%
	P		0–10%
	Q		0–20%
	R		0–40%
	S		0–50%
	T		0–70%
	U		0–100%
	N		Not Available
3rd Component 2nd Range (note2)	C		0–200 ppm
	D		0–250 ppm
	E		0–500 ppm
	F		0–1000 ppm
	G		0–2000 ppm
	H		0–5000 ppm
	J		0–1%
	K		0–2%
	L		0–3%
	M		0–5%
	P		0–10%
	Q		0–20%
	R		0–40%
	S		0–50%
	T		0–70%
	U		0–100%
	N		Not Available
4th Component 1st Range (note2)	B		0–100 ppm
	C		0–200 ppm
	D		0–250 ppm
	E		0–500 ppm
	F		0–1000 ppm
	G		0–2000 ppm
	H		0–5000 ppm
	J		0–1%
	K		0–2%
	L		0–3%
	M		0–5%
	P		0–10%
	Q		0–20%
	R		0–40%
	S		0–50%
	T		0–70%
	U		0–100%
	N		Not Available

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MODEL AND SUFFIX CODE

4th Component 2nd Range (note2)	C D E F G H J K L M P Q R S T U N		0–200 ppm 0–250 ppm 0–500 ppm 0–1000 ppm 0–2000 ppm 0–5000 ppm 0–1% 0–2% 0–3% 0–5% 0–10% 0–20% 0–40% 0–50% 0–70% 0–100% Not Available
O_2 Analyzer 1st Range (note2)	1 2 3 N		0–5% 0–10% 0–25% Not Available
O_2 Analyzer 2nd Range (note2)	2 3 N		0–10% 0–25% Not Available
Output	-4 -1		4–20 mA DC non-isolation 0–1 V DC non-isolation
Piping	R T		Rc 1/4 1/4 NPT
Indication	J E		Japanese English
Option	O_2 Correction and O_2 Avarage (note4) Communication Internal Purge (note5) Relay board (note6)	/K /A /C /P /R	With O_2 correction and O_2 average value With peak count alarm (CO gas Only) RS232C Analyzer internal purging With dedicated cable

T02-3.EPS

(note 1) External O_2 sensor signal should be 0-1 V DC linear of full scale.
(note 2) Allowable combinations of ranges are specified in the table 1-(1) to 1-(7).
(note 3) Allowed only for CO_2 analyzer (sigle component analyzer only).
(note 4) O_2 correction is carried out for CO and SO_2. At the same time, average value output after O_2 correction and O_2 average value are added. -Peak count alarm is carried out for CO.
(note 5) When an internal purge is specified with 3 and 4 component analyzer, the gas inlet/outle becomes only single-unit, and cannot put the NO_2/NO converter among.
(note 6) When the solenoid valve for an auto calibration is used,specify it.

Table 1. Measurable component and range – availability check table –

(1) Single-component analyzer (NO, SO_2, CO_2, CO or CH_4)

☆ : NO analyzer measurable range □ : SO_2 analyzer measurable range ◎ : CO_2 analyzer measurable range
○ : CO analyzer measurable range △ : CH_4 analyzer measurable range

2nd range / 1st range		B 0 to 100ppm	C 0 to 200ppm	D 0 to 250ppm	E 0 to 500ppm	F 0 to 1000ppm	G 0 to 2000ppm	H 0 to 5000ppm	J 0 to 1%	K 0 to 2%
A	0 to 50 ppm	◎	◎	◎	◎	◎	—	—	—	—
B	0 to 100 ppm	—	☆□◎○	☆□◎○	☆□◎○	☆□◎○	☆□◎○	—	—	—
C	0 to 200 ppm	—	—	☆□◎○	☆□◎○	☆□◎○	☆□◎○	—	—	—
D	0 to 250 ppm	—	—	—	☆□◎○	☆□◎○	☆□◎○	☆□◎○	—	—
E	0 to 500 ppm	—	—	—	—	☆□◎○△	☆□◎○△	☆□◎○△	□◎○△	—
F	0 to 1000 ppm	—	—	—	—	—	☆□◎○△	☆□◎○△	□◎○△	□◎○△
G	0 to 2000 ppm	—	—	—	—	—	—	☆□◎○△	□◎○△	□◎○△
H	0 to 5000 ppm	—	—	—	—	—	—	—	□◎○△	□◎○△
J	0 to 1%	—	—	—	—	—	—	—	—	□◎○△
K	0 to 2%	—	—	—	—	—	—	—	—	—
L	0 to 3%	—	—	—	—	—	—	—	—	—
M	0 to 5%	—	—	—	—	—	—	—	—	—
P	0 to 10%	—	—	—	—	—	—	—	—	—
Q	0 to 20%	—	—	—	—	—	—	—	—	—
R	0 to 40%	—	—	—	—	—	—	—	—	—
S	0 to 50%	—	—	—	—	—	—	—	—	—
T	0 to 70%	—	—	—	—	—	—	—	—	—
U	0 to 100%	—	—	—	—	—	—	—	—	—

2nd range / 1st range		L 0 to 3%	M 0 to 5%	P 0 to 10%	Q 0 to 20%	R 0 to 40%	S 0 to 50%	T 0 to 70%	U 0 to 100%
A	0 to 50ppm	—	—	—	—	—	—	—	—
B	0 to 100ppm	—	—	—	—	—	—	—	—
C	0 to 200ppm	—	—	—	—	—	—	—	—
D	0 to 250ppm	—	—	—	—	—	—	—	—
E	0 to 500ppm	—	—	—	—	—	—	—	—
F	0 to 1000ppm	—	—	—	—	—	—	—	—
G	0 to 2000ppm	□◎○△	—	—	—	—	—	—	—
H	0 to 5000ppm	□◎○△	□◎○△	□◎○△	—	—	—	—	—
J	0 to 1%	□◎○△	□◎○△	□◎○△	◎○△	—	—	—	—
K	0 to 2%	□◎○△	□◎○△	□◎○△	◎○△	◎○△	—	—	—
L	0 to 3%	—	◎○△	□◎○△	◎○△	◎○△	◎○△	—	—
M	0 to 5%	—	—	□◎○△	◎○△	◎○△	◎○△	◎○△	◎○△
P	0 to 10%	—	—	—	◎○△	◎○△	◎○△	◎○△	◎○△
Q	0 to 20%	—	—	—	—	◎○△	◎○△	◎○△	◎○△
R	0 to 40%	—	—	—	—	—	◎○△	◎○△	◎○△
S	0 to 50%	—	—	—	—	—	—	◎○△	◎○△
T	0 to 70%	—	—	—	—	—	—	—	◎○△
U	0 to 100%	—	—	—	—	—	—	—	◎○△

T03.eps

(2) Double-component analyzer (NO and SO_2)

○ : Double components measurable range. 1st component ; NO, 2nd component ; SO_2

1st component ↓(NO), 1st range		2nd component (SO_2), 1st range → SO_2 B 0 to 100ppm	C 0 to 200ppm	D 0 to 250ppm	E 0 to 500ppm	F 0 to 1000ppm	G 0 to 2000ppm	H 0 to 5000ppm
NO	B 0 to 100ppm	○	○	○	○	○	○	—
	C 0 to 200ppm	○	○	○	○	○	○	—
	D 0 to 250ppm	○	○	○	○	○	○	○
	E 0 to 500ppm	○	○	○	○	○	○	○
	F 0 to 1000ppm	○	○	○	○	○	○	○
	G 0 to 2000ppm	○	○	○	○	○	○	○
	H 0 to 5000ppm	—	—	○	○	○	○	○

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(3) Double-component analyzer (NO and CO)

○ : Double components measurable range. 1st component ; NO, 2nd component ; CO.

1st component ↓ (NO), 1st range		2nd component (CO), 1st range → CO: B 0 to 100ppm	C 0 to 200ppm	D 0 to 250ppm	E 0 to 500ppm	F 0 to 1000ppm	G 0 to 2000ppm	H 0 to 5000ppm
NO	B 0 to 100ppm	○	○	○	○	○	○	—
	C 0 to 200ppm	○	○	○	○	○	○	—
	D 0 to 250ppm	○	○	○	○	○	○	○
	E 0 to 500ppm	○	○	○	○	○	○	○
	F 0 to 1000ppm	○	○	○	○	○	○	○
	G 0 to 2000ppm	○	○	○	○	○	○	○
	H 0 to 5000ppm	—	—	○	○	○	○	○

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(4) Double-component analyzer (CO_2 and CO)

○ : Double components measurable range. 1st component ; CO_2, 2nd component ; CO.

1st component ↓ (CO_2), 1st range		2nd component (CO), 1st range → CO: B 0 to 100ppm	C 0 to 200ppm	D 0 to 250ppm	E 0 to 500ppm	F 0 to 1000ppm	G 0 to 2000ppm	H 0 to 5000ppm	J 0 to 1%
CO_2	G 0 to 2000ppm	○	○	○	○	○	○	○	○
	H 0 to 5000ppm	○	○	○	○	○	○	○	○
	J 0 to 1%	—	—	—	○	○	○	○	○
	K 0 to 2%	—	—	—	—	○	○	○	○
	M 0 to 5%	—	—	—	—	—	○	○	○
	P 0 to 10%	○	○	○	○	○	○	○	○
	Q 0 to 20%	○	○	○	○	○	○	○	○

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* The interpretation of measurable range of double-component analyzer in (2), (3) and (4) is as follows.
First select the first range of respective components. Available if ○ .
This is all you have to do unless the second range is necessary. If the second range is necessary, it must be greater than and, smaller than 20 times, the first range, and, CO_2 and CO analyzer must meet the measurable combination of components in Table (1).

(5) Three-component analyzer (NO, SO_2 and CO)

NO/SO_2 analyzer must meet the combination range in Table 1-(2): Double-component analyzer. CO analyzer must meet the range in Table 1-(1): Single component analyzer.

(6) Four-component analyzer (NO, SO_2, CO_2 and CO)

NO/SO_2 analyzer must meet the combination range in Table 1-(2): Double-component analyzer. CO_2/CO analyzer must meet the range in Table 1-(4): Double-component analyzer.

(7) O_2 analyzer

○ : Built-in O_2 analyzer measurable range,
△ : External zirconia type O_2 analyzer measurable range

1st range		2nd range: 2 0 to 10%	3 0 to 25%
1	0 to 5%	○△	○△
2	0 to 10%	—	○△
3	0 to 25%	—	○△

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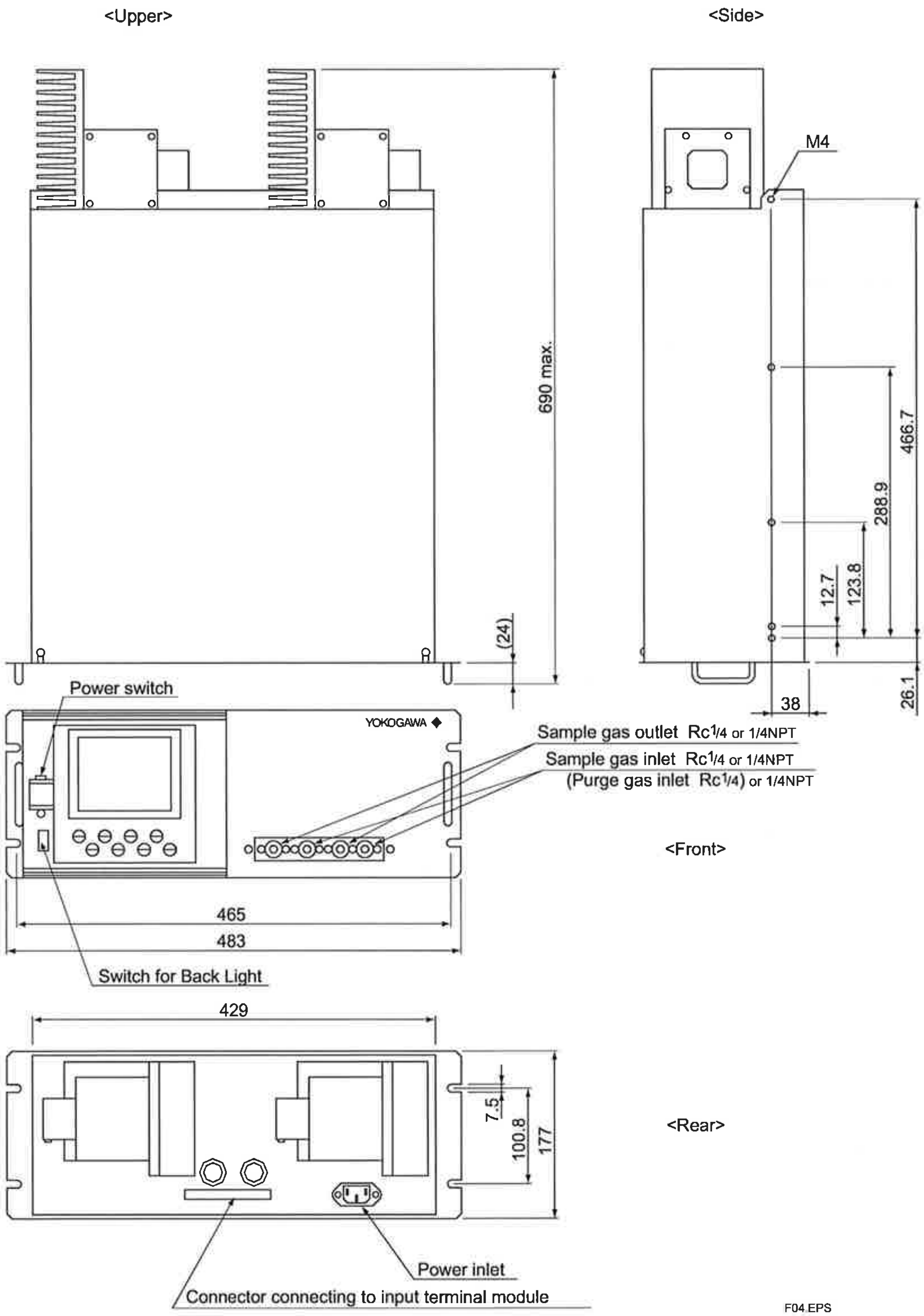
*O_2 analyzer is selectable indifferently to combination with other components.
External zirconia type O_2 analyzer is assumed to be YOKOGAWA's model ZX8D Style C.

EXTERNAL DEMENSIONS

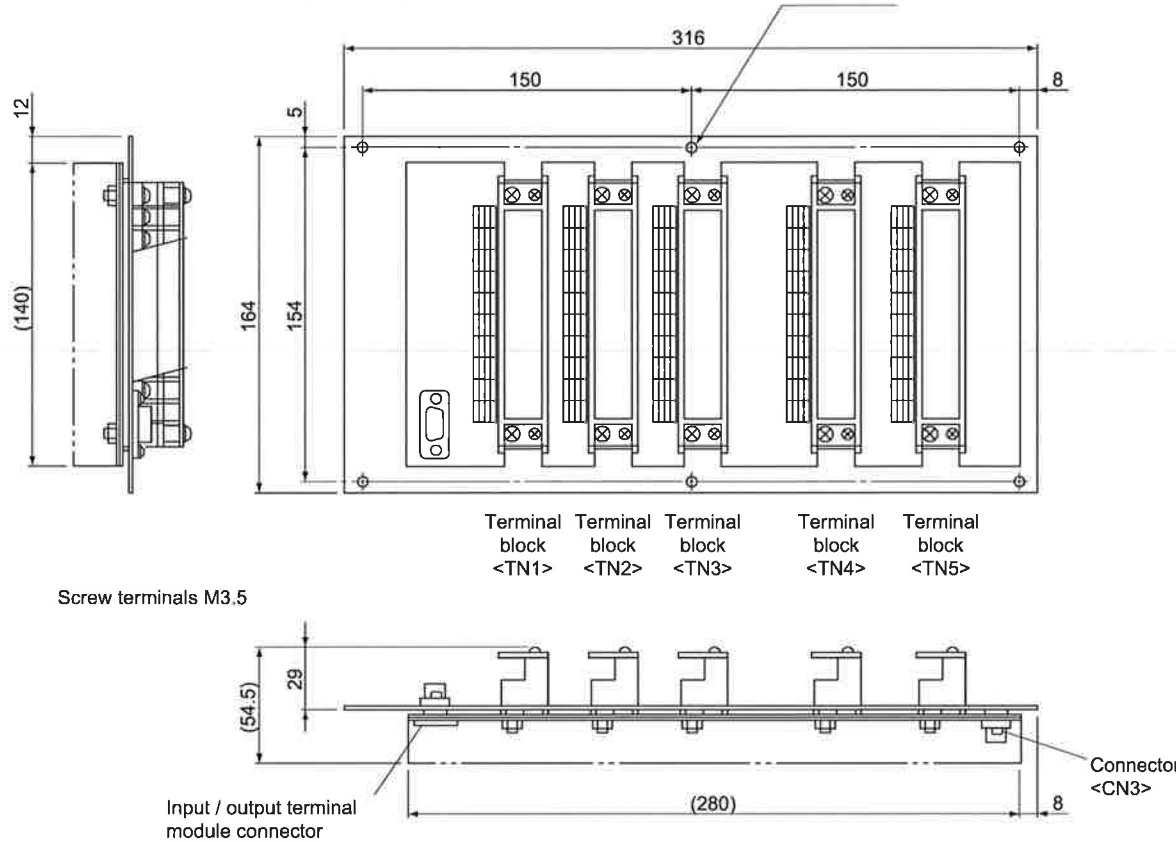
(Unit: mm)

<Analyzer main unit>

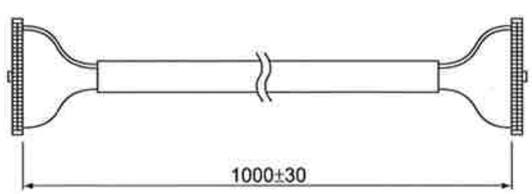


Unit: mm

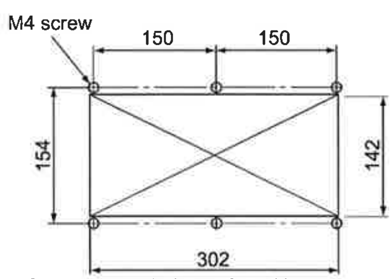
<Input / output terminal module K9218SC>
(Accessory)



<Cable for connecting input / output terminal K9218SD>
(Accessory)



<Dimensions for mounting input / output terminal module>



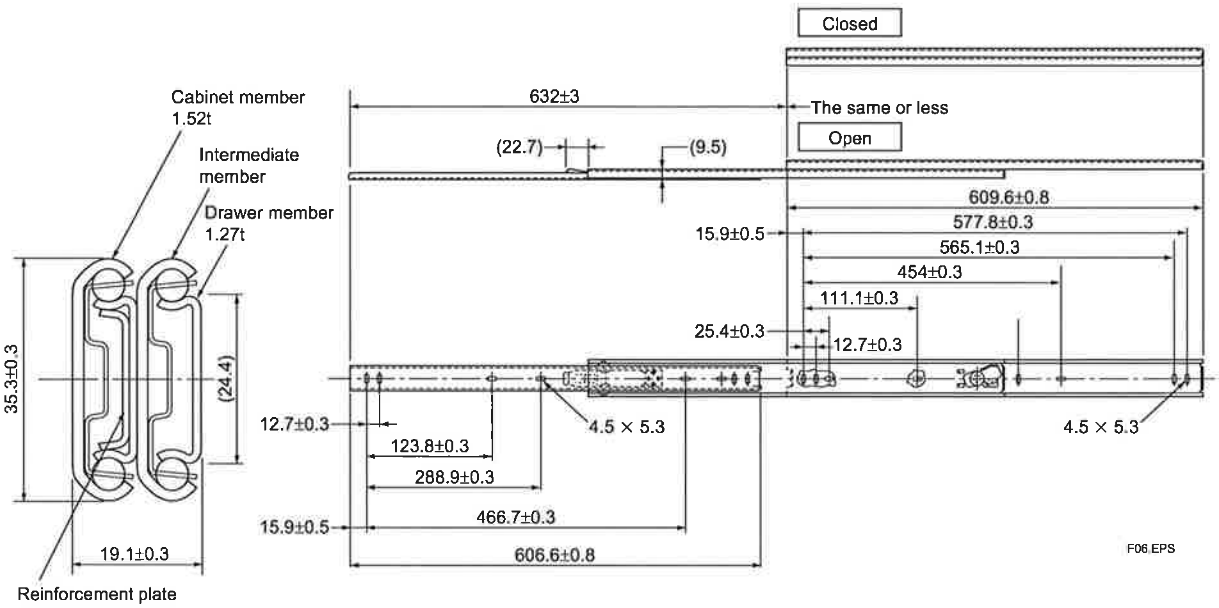
Cut M4 screw holes at 6 positions.
Drill a rectangular hole of 302 × 142 mm or more in the center.

F05.EPS

EXTERNAL DEMENSIONS of ACCESSORY SLIDE RAIL

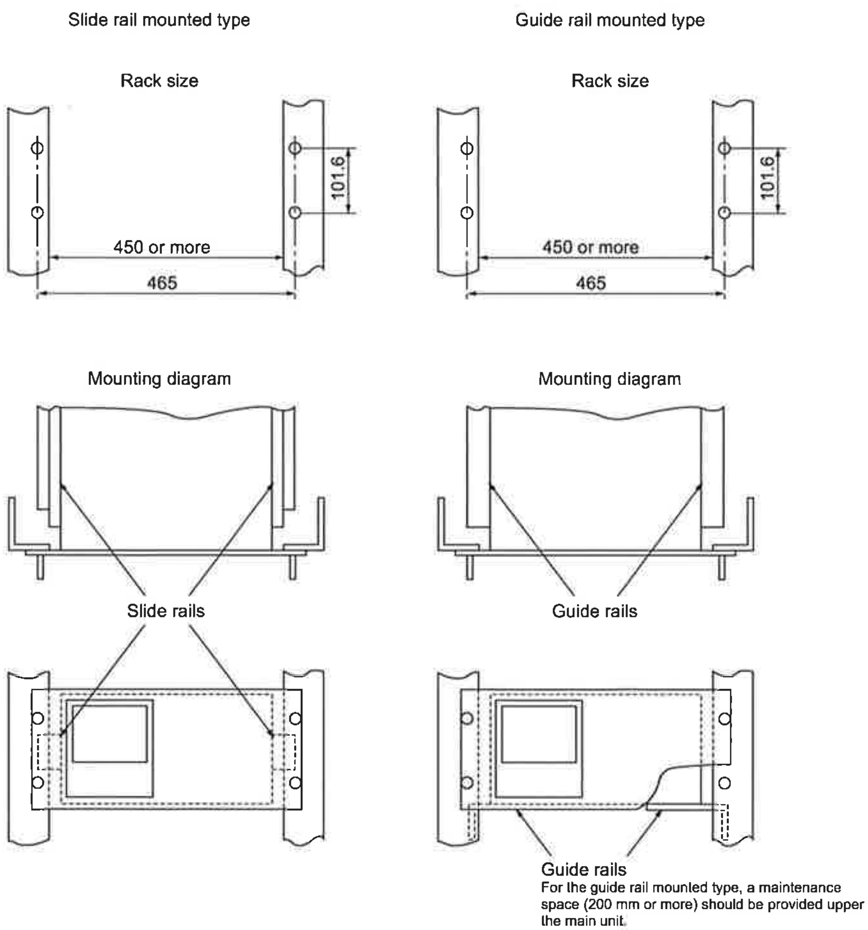
(Unit: mm)

Model : 305A-24/Accuride International Inc.

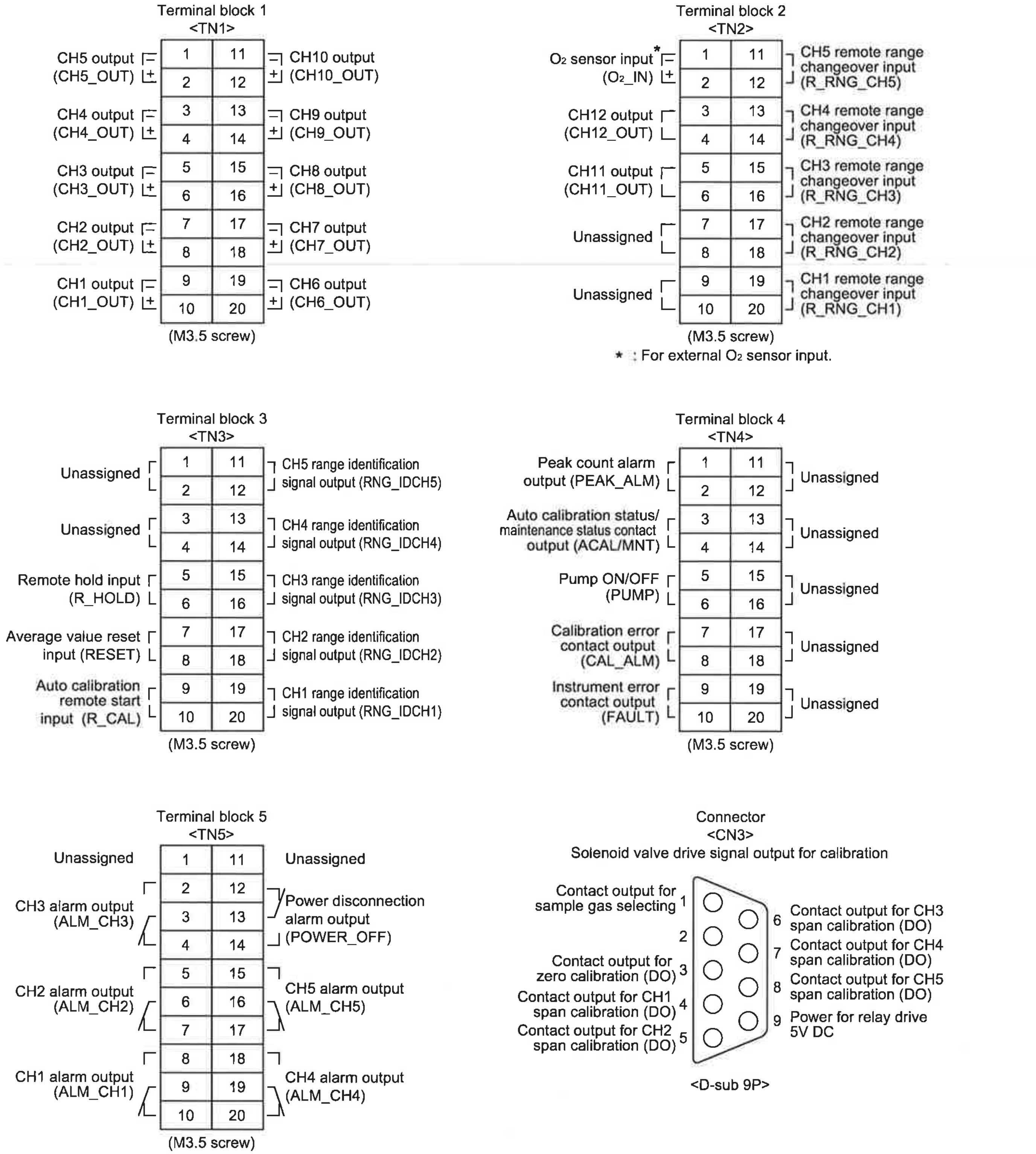


19-inch rack mounting method:

The mass of the instrument should be supported at the bottom of the unit (or the side of the unit when mounted with the slide rails). Also, for facilitate maintenance, a structure which allows extraction of the main unit by using the slide rail is recommended.



EXTERNAL CONNECTION DIAGRAM



Note 1) Unassigned terminals are used for internal connection. So they should not be used as repeating terminals either.

Note 2) The allocation of each channel (CH1 to CH12) depends on measured gas components. Refer to the table on the next page.

F08.EPS

Table 2. Correspondence between measurement channels and measured value

The following table gives measurement channels and their contents according to the code symbols.

Code symbol			Output corresponding to channels											
Measurable component	O_2 analyzer	O_2 correction	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12
-A	N	Not specified	NO											
-B	N	Not specified	SO_2											
-C	N	Not specified	CO_2											
-D	N	Not specified	CO											
-F	N	Not specified	CH_4											
-G	N	Not specified	NO	SO_2										
-H	N	Not specified	NO	CO										
-J	N	Not specified	CO_2	CO										
-K	N	Not specified	NO	SO_2	CO									
-L	N	Not specified	NO	SO_2	CO_2	CO								
-A	1, 2, 3	/K	NOx	O_2	Correct NOx	Correct NOx av.	O_2 av.							
-B	1, 2, 3	/K	SO_2	O_2	Correct SO_2	Correct SO_2 av.	O_2 av.							
-D	1, 2, 3	/K	CO	O_2	Correct CO	Correct CO av.	O_2 av.							
-F	1, 2, 3	/K	CH_4	O_2	O_2 av.									
-G	1, 2, 3	/K	NOx	SO_2	O_2	Correct NOx av.	Correct SO_2	Correct NOx av.	Correct SO_2 av.	O_2 av.				
-H	1, 2, 3	/K	NOx	CO	O_2	Correct NOx	Correct CO	Correct NOx av.	Correct CO av.	O_2 av.				
-J	1, 2, 3	/K	CO_2	CO	O_2	Correct CO av.	Correct CO av.	O_2 av.						
-K	1, 2, 3	/K	NOx	SO_2	CO	O_2	Correct NOx	Correct SO_2	Correct CO	Correct NOx av.	Correct SO_2 av.	Correct CO av.	O_2 av.	
-L	1, 2, 3	/K	NOx	SO_2	CO_2	CO	O_2	Correct NOx	Correct SO_2	Correct CO	Correct NOx av.	Correct SO_x av.	Correct CO av.	O_2 av.
-D	1, 2, 3	except /K	CO	O_2										
-H	1, 2, 3	except /K	NO	CO	O_2									
-J	1, 2, 3	except /K	CO_2	CO	O_2									
-K	1, 2, 3	except /K	NO	SO_2	CO	O_2								
-L	1, 2, 3	except /K	NO	SO_2	CO_2	CO	O_2							

T08.EPS

(note) ▭ : As for the NO meter within this range, the display on the indicator become NOx.
The peak count alarm becomes a contact output.
The "correct" means O_2 correction.
The "av." means avarage value.

ACCESSORY PARTS

No	Name	PARTS No.	Qty	Description
1	Power cable	K9218SA	1	standard inlet type 2 m
2	Fuse	K9218SB	2	replacement fuse 250 V, 3 AC, delay type
3	Input/output terminal module	K9218SC	1	input/output terminal module for external mouting
4	Connection cable	K9218SD	1	connection cable (1 m) between main unit and input/output terminal module
5	Slider rail	K9218SE	2	slider rail

T09.EPS

(note) Content of specifications is content of one part.
That is, if K9218SE is ordered, it becomes one rail.
Two K9218SE attaches as a standard of accessory.
That is, two rails are a attached.

PARTS No. of DEDICATED RELAY BOARD

No.	Names	PARTS No.	Qty	Description
1	Relay board	K9218SF	1	for external point of contact
2	Cable	K9218SG	1	for relay board

T10.EPS

Exclusive Zirconia O_2 Sensor
(to be purchased separately)

For O_2 correction, the gas analyzer IR400 can accept linealized 0 to 1 V DC signal coming from analyzer calibrated 0 to 25% O_2 full scale. If the analyzer is not available, YOKOGAWA can supply exclusive Zirconia O_2 sensor Model ZX8D.

Measuring method:
Zirconia system

Measurable component and measuring range:

Measurable compoment		Minimum range	Maximum range
O2	Oxygen	0 to 5 vol%	0 to 25 vol%

T11.EPS

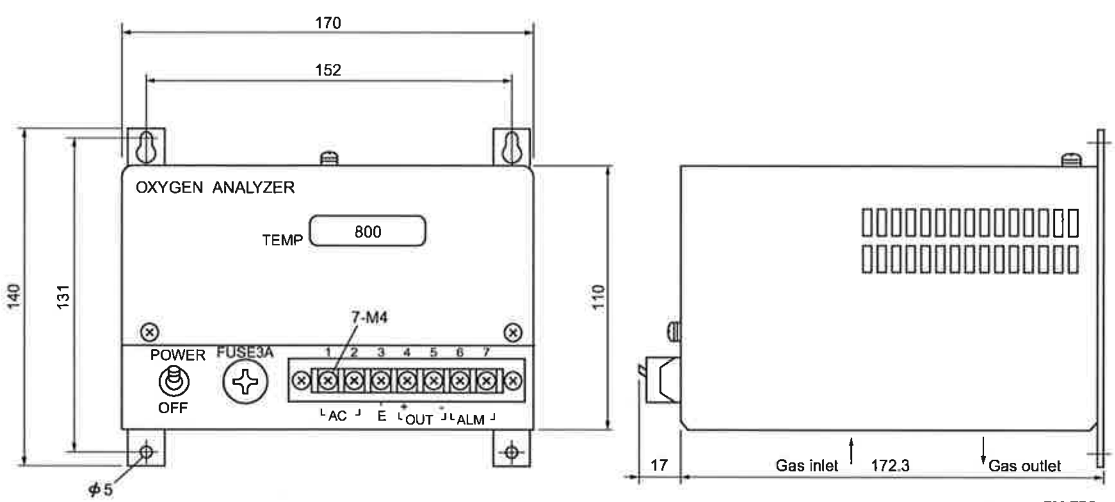
Repeatability: Within ± 0.5% of full scale
Linearity: Within ± 1% of full scale
Zero drift: Within ± 1% of full scale/week
Span drift: Within ± 2% of full scale/week
Response time:
Approx. 20 seconds (for 90% response)
Measured gas flow rate:
0.5 ± 0.25 L / min
Remark: The Zirconia system, due to its principle, may produce a measuring error due to relative concentration versus the combustible O_2 gas concentration. Also, a corrosive gas (SO_2 of 250 ppm or more, etc.) may affect the life of the sensor.
Gas inlet/outlet size:
Rc1/4
Power supply: 90 to 126 V AC or 200 to 240 V AC, 50/60 Hz
Enclosure: Steel casing, for indoor application
Indication: Temperature indication (LED)
Temperature alarm output:
Contact output 1a contact,
Contact capacity 220 V AC, 1 A (resistive load)
Dimensions (H × W × D):
140 × 170 × 190 mm
Weight: Approx. 3 kg
Finish color: Munsell 5Y 7/1

MODEL	Suffix code	Option code	Description
ZX8D			Exclusive Ziroconia 02 Sensor
Power supply	-5 -3		90 to126 V AC, 50/60 Hz 200 to 240 V AC, 50/60 Hz
Style code	*C		Style C (IR200, IR400)

T12.EPS

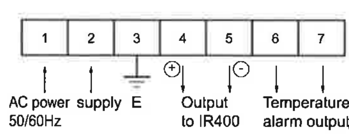
EXTERNAL DEMENSIONS of ZX8D

(Unit:mm)



F09.EPS

EXTERNAL CONNECTION DIAGRAM



Dedicated relay board (Option code: /R)

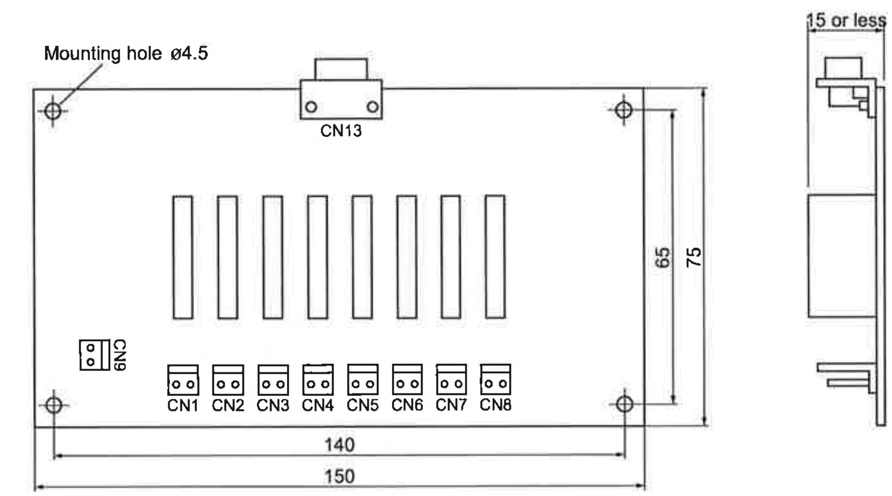
This relay board receives signals from connector CN3 of the IR400 I/O terminal module and activates the calibration solenoid valve directly.

- Relay contact : 1 normally closed contact
  Contact capacity; 250 V AC/2 A
  (resistive load)

Parts Number
  Dedicated relay board: K9218SF
  Dedicated cable: K9218SG

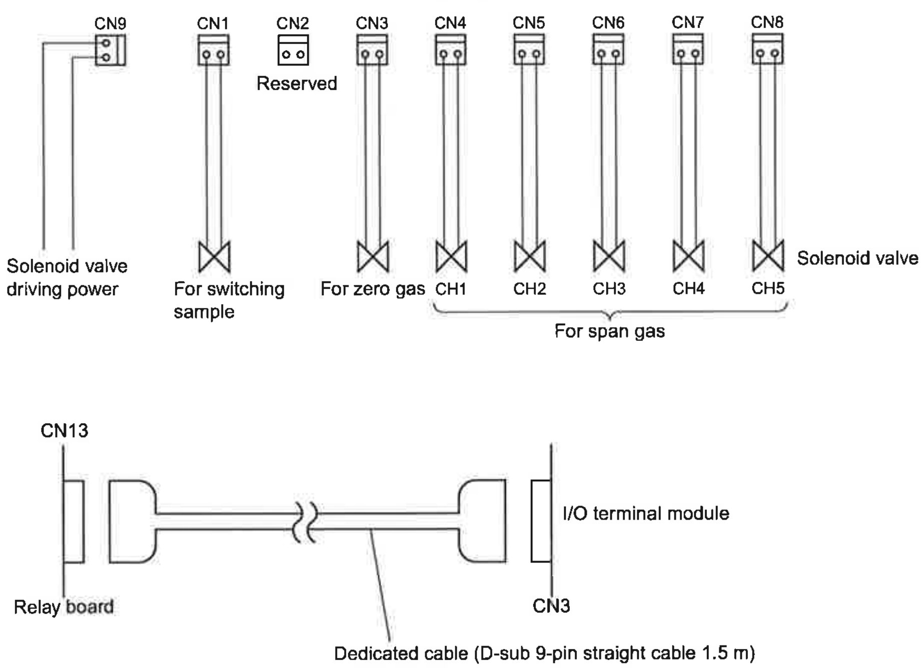
EXTERNAL DEMENSIONS

(Unit: mm)



F10.EPS

CONNECTIONS



F11.EPS

Contact action

- During measurement : CN1 ; ON
  Others ; OFF
- During calibration : CN1 ; OFF
  Others ; Contact corresponding to calibration timing is ON

Recommended connector

- CN1 to CN8 : Housing ; VHR-2N
  (Nihon Solderless Terminal)
  Contact ; SVH-21T-1.1
  (Nihon Solderless Terminal)

Inquiry Sheet for IR400 NDIR Type Infrared Gas Analyzer

Place a checkmark ✓ in the appropriate box and fill in the specific information in the blanks for your reference.

1. General Information

Company : ____________ Delivery destination : ____________
Responsible person : ____________ Section : ____________ (Phone No. ____)
Plant name : ____________ Measurement location : ____________
Purpose : ☐ Indication reading, ☐ Recording, ☐ Telemeter transmission, ☐ Alarm, ☐ Control, ☐ Other ______

2. Requirements

Measurable component:

	1st	2nd	3rd	4th
☐	NO			
☐	SO_2			
☐	CO_2			
☐	CO			
☐	CH_4			
☐	NO	SO_2		
☐	NO	CO		
☐	CO_2	CO		
☐	NO	SO_2	CO	
☐	NO	SO_2	CO_2	CO

O_2 Analyzer:
- ☐ Not available
- ☐ External zirconia type sensor (use ZX8D Style C)
- ☐ External O_2 Analyzer
- ☐ Built-in paramagnetic type O_2 Sensor

Range:

1st component, 1st range	1st component, 2nd range	2nd component, 1st range	2nd component, 2nd range
☐ 0 – 50 ppm	☐ 0 – 100 ppm	☐ 0 – 100ppm	☐ 0 – 200 ppm
☐ 0 – 100 ppm	☐ 0 – 200 ppm	☐ 0 – 200 ppm	☐ 0 – 250 ppm
☐ 0 – 200 ppm	☐ 0 – 250 ppm	☐ 0 – 250 ppm	☐ 0 – 500 ppm
☐ 0 – 250 ppm	☐ 0 – 500 ppm	☐ 0 – 500 ppm	☐ 0 – 1000 ppm
☐ 0 – 500 ppm	☐ 0 – 1000 ppm	☐ 0 – 1000 ppm	☐ 0 – 2000 ppm
☐ 0 – 1000 ppm	☐ 0 – 2000 ppm	☐ 0 – 2000 ppm	☐ 0 – 5000 ppm
☐ 0 – 2000 ppm	☐ 0 – 5000 ppm	☐ 0 – 5000 ppm	☐ 0 – 1%
☐ 0 – 5000 ppm	☐ 0 – 1%	☐ 0 – 1%	☐ 0 – 2%
☐ 0 – 1%	☐ 0 – 2%	☐ 0 – 2%	☐ 0 – 3%
☐ 0 – 2%	☐ 0 – 3%	☐ 0 – 3%	☐ 0 – 5%
☐ 0 – 3%	☐ 0 – 5%	☐ 0 – 5%	☐ 0 – 10%
☐ 0 – 5%	☐ 0 – 10%	☐ 0 – 10%	☐ 0 – 20%
☐ 0 – 10%	☐ 0 – 20%	☐ 0 – 20%	☐ 0 – 40%
☐ 0 – 20%	☐ 0 – 40%	☐ 0 – 40%	☐ 0 – 50%
☐ 0 – 40%	☐ 0 – 50%	☐ 0 – 50%	☐ 0 – 70%
☐ 0 – 50%	☐ 0 – 70%	☐ 0 – 70%	☐ 0 – 100%
☐ 0 – 70%	☐ 0 – 100%	☐ 0 – 100%	☐ Not available
☐ 0 – 100%	☐ Not available	☐ Not available	

3rd component, 1st range	3rd component, 2nd range	4th component, 1st range	4th component, 2nd range
☐ 0 – 100 ppm	☐ 0 – 200 ppm	☐ 0 – 100 ppm	☐ 0 – 200 ppm
☐ 0 – 200 ppm	☐ 0 – 250 ppm	☐ 0 – 200 ppm	☐ 0 – 250 ppm
☐ 0 – 250 ppm	☐ 0 – 500 ppm	☐ 0 – 250 ppm	☐ 0 – 500 ppm
☐ 0 – 500 ppm	☐ 0 – 1000 ppm	☐ 0 – 500 ppm	☐ 0 – 1000 ppm
☐ 0 – 1000 ppm	☐ 0 – 2000 ppm	☐ 0 – 1000 ppm	☐ 0 – 2000 ppm
☐ 0 – 2000 ppm	☐ 0 – 5000 ppm	☐ 0 – 2000 ppm	☐ 0 – 5000 ppm
☐ 0 – 5000 ppm	☐ 0 – 1%	☐ 0 – 5000 ppm	☐ 0 – 1%
☐ 0 – 1%	☐ 0 – 2%	☐ 0 – 1%	☐ 0 – 2%
☐ 0 – 2%	☐ 0 – 3%	☐ 0 – 2%	☐ 0 – 3%
☐ 0 – 3%	☐ 0 – 5%	☐ 0 – 3%	☐ 0 – 5%
☐ 0 – 5%	☐ 0 – 10%	☐ 0 – 5%	☐ 0 – 10%
☐ 0 – 10%	☐ 0 – 20%	☐ 0 – 10%	☐ 0 – 20%
☐ 0 – 20%	☐ 0 – 40%	☐ 0 – 20%	☐ 0 – 40%
☐ 0 – 40%	☐ 0 – 50%	☐ 0 – 40%	☐ 0 – 50%
☐ 0 – 50%	☐ 0 – 70%	☐ 0 – 50%	☐ 0 – 70%
☐ 0 – 70%	☐ 0 – 100%	☐ 0 – 70%	☐ 0 – 100%
☐ 0 – 100%	☐ Not available	☐ 0 – 100%	☐ Not available
☐ Not available		☐ Not available	

O_2 Analyzer, 1st range	O_2 Analyzer, 2nd range
☐ 0 – 5%	☐ 0 – 10%
☐ 0 – 10%	☐ 0 – 25%
☐ 0 – 25%	☐ Not available
☐ Not available	

Output	: ☐ 4 – 20 mA DC	☐ DC 0 – 1 V	☐ RS-232C
O_2 Correction and O_2 Average	: ☐ Yes	☐ No	
Peak count alarm	: ☐ Yes	☐ No	
Relay board with peak count alarm	: ☐ Yes	☐ No	

3. Sample gas

Fuel : ☐ Gas, ☐ Oil, ☐ Coal, ☐ Refuse, ☐ Other fuel ________

(1) Temperature : ____________ to ____________, Normal temperature ____________ [°C]

(2) Pressure : ____________ to ____________, Normal pressure ____________ [MPa]

(3) Humidity : ____________ [vol%]

(4) Dust : ____________ [mg/Nm³]

(5) Corrosive gas : ☐ Yes ____________ ☐ No

Composition (It is important, and fill in a detailed composition from the meaning which knows the influence of the interference gas, please.)

Contents	Concentration range		
CO	________ to ________	☐ %	☐ ppm
CO_2	________ to ________	☐ %	☐ ppm
CH_4	________ to ________	☐ %	☐ ppm
H_2	________ to ________	☐ %	☐ ppm
O_2	________ to ________	☐ %	☐ ppm
N_2	________ to ________	☐ %	☐ ppm
SO_2	________ to ________	☐ %	☐ ppm
NOx	________ to ________	☐ %	☐ ppm
H_2O	________ to ________	☐ %	☐ ppm
________	________ to ________	☐ %	☐ ppm

From: Branson, Eric
To: Potter, Dolly; Skogley, Bob; Stuble, Bill; Brown, Tim
Subject: FW: Yokogawa CEMS
Date: Thursday, March 25, 2004 8:11:19 AM
Attachments: IR400 General Spec Sheet.pdf
IR200 General Spec Sheet.pdf

FYI,

CEM stack monitoring for CA-1/2 stack...

Eric

-----Original Message-----
From: peter.bowers@measurementation.com [mailto:peter.bowers@measurementation.com]
Sent: Wednesday, March 24, 2004 12:37 PM
To: Branson, Eric
Cc: toddjudd@pp-co.com; darryl.hazlett@measurementation.com; john.williams@measurementation.com
Subject: Yokogawa CEMS

Dear Mr. Branson,
I am with Measurementation. We are the division of Yokogawa that does analyzer system integration work. Mr. Todd Judd of Process Engineered Products contacted us today to inquire about an upcoming CEMS project that you have in the works. I have attached the information on the IR200 and IR400, the Yokogawa analyzer used for CEM applications. I had mentioned to Todd that it would be helpful if we could get an application inquiry data sheet filled out (at least as much as possible) so that we may create a proposal for a CEMS that fits your application. It is the last couple pages of the attachments. This data sheet asks for the basics, temp., pressure, desired measurements, etc...

Also, if you have any specifications that will apply to such a project, please forward those along with the completed data sheet(s).

Todd also mentioned an SG800 by Yokogawa (possibly a prepackaged CEMS??). I will look to see what information we have on that product as well.

Please feel free to contact myself or Darryl Hazlett (cc'd above) if you have any questions. Looking forward to hearing from you.

Thanks and best regards,

Peter G. Bowers
Proposals Manager
Measurementation Division
Yokogawa Corporation of America
Office (936) 653-2120
Cell (281) 814-1340
Fax (936) 653-5232